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## CERCIS IN NORTH AMERICA<sup>1</sup>

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INTRODUCTION.—In the course of investigations on the ecology and phytogeography of the Arbuckle Mountains in south-central Oklahoma I find the redbuds to be one of several genera which have given ample evidence that they are not at present clearly understood, either there or in other regions in the west and southwest. This xeric plateau of limestone outcrops with its unique flora of Texan affinities and its interesting geological formations has proved and is still proving to be an area of considerable importance botanically.

Two kinds of redbud are found in the Arbuckles in close proximity to each other. One is *Cercis canadensis*, both the typical form with slightly pubescent leaves and the glabrous form, f. *glabrifolia*; the other is *C. canadensis* var. *texensis* (*C. texensis* or *C. reniformis*). For several years I have been trying to separate these two plants on some basis other than leaf-shape but have been unable to do so. *C. canadensis* is very easily recognized both in the field and on the herbarium sheet, but the var. *texensis*, although its leaves are generally reniform in outline, frequently is so similar that complete segregation is difficult.

Because the two entities were so difficult to distinguish, I ventured to study all the living material of *Cercis* which was available. Collecting trips were made and ample specimens in all stages of development were obtained. Herbarium sheets were borrowed from the Herbarium of the Missouri Botanical Garden,

<sup>1</sup> Contribution from the Botanical Laboratory, University of Oklahoma, No. 65.

the Gray Herbarium, the United States National Herbarium, the Herbarium of the New York Botanical Garden, and the Herbarium of the Texas Agricultural and Mechanical College. To the curators of these herbaria I am most grateful for their kindness in permitting me to examine their material. In the citation of specimens the various herbaria are designated by the following letters: Herbarium of the Missouri Botanical Garden—(MBG); Gray Herbarium—(G); U. S. National Herbarium—(US); Herbarium of the N. Y. Botanical Garden—(NY); Herbarium of the Texas A. & M. College—(TAM); Herbarium of the Univ. of Okla.—(OU).

Except for the Britton and Rose<sup>1</sup> synopsis of *Cercis* in the North American Flora, no detailed monographic work has been done on the genus.<sup>2</sup> Previous to their work, no study was made except the treatments in the manuals and floras and these were usually scanty and inadequate. The Californian and Texan plants were considered by many botanists to be identical although Asa Gray clearly differentiated the two. Until Britton and Rose's study the synonymy of the entire genus was confused. Even their monograph failed to designate or establish any type specimens. Inasmuch as it was necessary to study the Texas material in connection with my floristic work in the Arbuckles, it seemed wise to examine the entire genus in America from the viewpoint of a monographer and to present the results of this study in the following pages.

The genus in North America, as I interpret it, includes only two species. One of these, *C. occidentalis*, is restricted to areas west of the Rocky Mountains, chiefly to California, but also occurs locally in the neighboring states of Arizona, Utah, and Nevada. The other is *C. canadensis* with a much broader range throughout eastern and central United States and with several varieties and forms. It is impossible for me to view the genus as consisting of several species, as the previous investigators have

<sup>1</sup> In N. Am. Fl. 23. pt. 4. 201-202 (1930).

<sup>2</sup> Unless one may call the four-page discussion by Greene (in Fedde, Rep. Sp. Nov. 11. 108-111. 1912), in which he described 7 new species, a monograph. He adds: "Not that there are not more or less plain indications of several more; but I leave that work to the future, and for further investigation, now taking in hand mainly certain hitherto undescribed species belonging to the farther Southwest and West." Inasmuch as not one of the 7 new species described by Greene in this paper is now considered valid, perhaps it is fortunate that "the future" investigations were not conducted by him!

considered it, because the specific lines are essentially weak. Nor do herbarium sheets show these specific differences at all clearly. I have several sheets before me at the moment, and I cannot ascertain whether they are *C. canadensis* or the var. *texensis*. If I saw the living plant from which each was cut, I should probably be able to distinguish the two very clearly. Many keys in our manuals and floras are based, not on living specimens which illustrate so clearly the differences in external morphology, but rather on herbarium specimens which show only seldom those important characteristics that make one species taxonomically different from another.

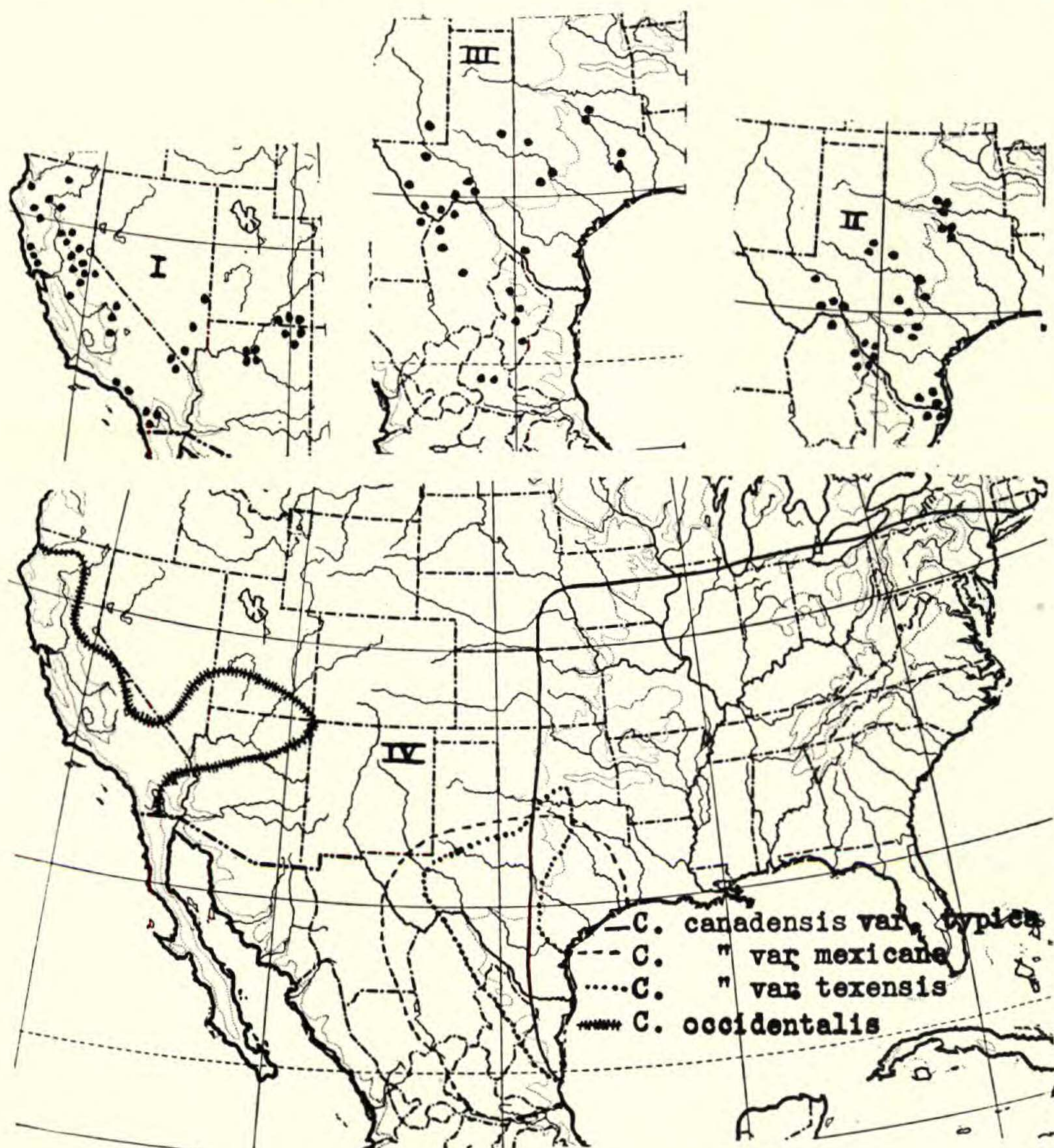
The following artificial key will help in pointing out those differences which occur among the various taxonomic units, while other notes pertaining to this treatment may be found in the discussion of each.

- A. Fruit 1.8–2.5 cm. broad; petals averaging 9 mm. in length; plants of California and neighboring states. . . . . 1. *C. occidentalis*
- A. Fruit 0.8–1.8 cm. broad; petals averaging 7.5 mm. or less in length; plants of Mexico, Texas, and northeastward.
  - B. Mature leaves thinnish, dull green on both surfaces, generally cordate in outline, generally acute at apex.
    - C. Young leaves pubescent beneath, the mature ones with a few hairs on the under surface, especially along the lower parts of the principal veins on the under surface; otherwise glabrous. . . . . 2. *C. canadensis* Var. *typica*.
    - C. Leaves quite glabrous on both sides at all stages of development. . . . . 2a. *C. canadensis* f. *glabrifolia*.
  - B. Mature leaves coriaceous to subcoriaceous, rich deep green, shining, and distinctly glaucous above, reniform to cordate-reniform in outline, obtuse to emarginate at apex, often merely rounded.
    - C. Pedicels and young branchlets quite glabrous at all times, leaves entirely so. . . . . 2b. *C. canadensis* Var. *texensis*.
    - C. Pedicels and young branchlets densely wooly-tomentose both in youth and maturity, leaves slightly so. . . . . 2c. *C. canadensis* Var. *mexicana*.

1. *C. OCCIDENTALIS* Torrey ex A. Gray. Spreading shrub forming thickets with clumps of erect, clustered stems, at maturity 2–4.5 m. high; bark light gray to grayish brown punctate with numerous whitish lenticels; stems and branchlets glabrous throughout: leaves orbicular and suborbicular to reniform, light green with yellowish or often whitish tinge, glabrous to subglaucous on both surfaces, palmately 7–9-veined, entire, subcoriaceous to coriaceous, 3–9 cm. broad, 2–5 cm. long (from apex to top of sinus); base cordate with broad (max. 3 cm.) to narrow and nearly closed (min. 3 mm.) sinus; apex retuse to emarginate or sometimes cuspidate, often merely rounded; petioles glabrous

12–35 mm. long, stipules caducous: flowers in sessile umbels or fascicles appearing in the spring before the leaves, 2–6 in each cluster, magenta pink to reddish purple; corolla obscurely papilionaceous, 8–12 mm. long; flowering pedicels 7–11 mm. long: pods abundant, oblong, flat, the upper suture with a conspicuous winged margin, 4–9 cm. long, 1.8–2.5 mm. broad at maturity, attenuate or abruptly acute at apex; fruiting pedicels divaricate to pendulous and somewhat arcuate, 10–14 mm. long; seeds orbicular, 3–4 mm. in diameter, but few mature ones in a pod.—Bost. Journ. Nat'l. Hist. (Plantae Lindheimerianae, pt. 2) **6**. 177 (1850); Jepson, Fl. W. Mid. Calif. ed. 1, 289 (1901); ed. 2, 215 (1911); Man. Fl. Pl. Calif. 511 (1925); Tidestrom, Fl. Utah & Nev. in Contr. U. S. Nat'l. Herb. **25**. 287 (1925); Britton & Rose in N. Am. Fl. **23**, pt. 4. 202 (1930); Munz, Man. s. Calif. Bot. 243 (1935); Jepson, Fl. Calif. **2**. 238 (1936). *C. californica* Torr. ex Benth., Pl. Hartw. 361 (1857). *Siliquastrum occidentale* Greene, Man. Reg. S. F. Bay 84 (1894). *C. nephrophylla* Greene in Fedde, Rep. Sp. Nov. **11**. 111 (1912). *C. orbiculata* Greene in Fedde, Rep. Sp. Nov. **11**. 111 (1912); Tidestrom in Contr. U. S. Nat'l. Herb. **25**. 287 (1925). *C. latissima* Greene in Fedde, Rep. Sp. Nov. **11**. 111 (1912). *C. occidentalis* var. *orbiculata* (Greene) Tidestr. Fl. Ariz. and N. Mex. 155 (1941).—Rocky stream-banks, canyons, hillsides and chaparral, California east to e. Arizona, w. Utah and sw. Nevada. The following are a few of the characteristic specimens. CALIFORNIA: in California, without definite locality, *Hartweg*, no. 1706 [TYPE Kew; ISOTYPE N. Y.]; “Bois rouge, frequent along streams on the upper part of the Sacramento” 8 April & 27 May 1846, *Fremont's Expedition to Calif.*; chaparral, Middle Tulare, *Purpus*, no. 5608 [MBG, G, US]; at the Geysers, Sonoma Co., *Bolander*, no. 3946 [MBG, G, US]; Cuyamaca Mts., *Edward Palmer*, no. 72 [MBG, NY]; Pleasant Valley, Napa River Basin, *Jepson*, 23 May 1897 [MBG, G]; Rumsey, Yola Co., *C. F. Baker*, no. 2935 [MBG, G, US]; California, *Fremont*, 1845–7 [MBG, G, NY]; between Cuyamaca & Oriflamme mines, San Diego Co., *Abrams*, no. 3924 [MBG, G, US, NY]; Borax Lake, *J. Torrey*, no. 108 [MBG, G, NY]; open woods, Mt. Konocti, 2000 ft., Lake Co., *Blankinship*, 17 April 1929 [MBG]; California, without locality, *Vasey*, 1875 (type of *C. nephrophylla* Greene) [US]; mountains of central Calif., *G. B. Grant*, July 1902 (type of *C. latissima* Greene) [US]. ARIZONA: without definite locality or date, *Otto Kuntze* [NY]; canyon 2 miles below Pagumpa, *M. E. Jones*, no. 5089 [MBG, US, NY]; Hermit Creek near camp, Grand Canyon, *Eastwood*, no. 6010 [G]; frequent along creek below El Tovar, Grand Canyon, alt. 3000 ft., *Hanson & Hanson*, no. A739 [MBG]; Bright Angel Trail, Grand Canyon National Park, Coconino Co., *C. B. Wolf*, no. 3187 [G]; north slope Superstition Mts., *Goodding*, 15 May

1937 [US]; Grand Canyon, *Sturdevant*, May 1927 (as *C. arizonica* Rose, n. sp.) [US, NY]; Grand Canyon, Indian Gardens, *Goldman*, no. 2231 (as *C. arizonica*) [US, NY]. UTAH: rocky cañons, Diamond Valley, *Goodding*, no. 899 (type of *C. orbiculata* Greene)



MAP I, Range of *CERCIS OCCIDENTALIS*; II, of *C. CANADENSIS* var. *TEXENSIS*; III, of *C. CANADENSIS* var. *MEXICANA*; IV, areas in North America represented by species of *CERCIS*.

[MBG, NY, US]; Red Bud Pass on Bernheimer Trail to Rainbow Bridge, San Juan Co., *H. C. Cutler*, no. 2850 [NY]. NEVADA: Willow Springs, La Madre Mts., alt. 1200 m., Clark Co., *Clokey*, nos. 7978 & 7979 [G, NY]; near mountain spring, Charleston Mts., *Vernon Bailey, Coville & Funston*, no. 1883 [US]; vicinity of Kayenta, *John Wetherill*, 1922 [NY]. *Fl.* Feb.—Apr. MAP I.

Because there might be some confusion as to the type specimen of *C. occidentalis* it is appropriate here to give a brief history of the name.

It was first published by Gray in *Plantae Lindheimerianae* thereby validating the unpublished and earlier epithet of Torrey. Gray took it up for a variety of Bentham's which was described but not named. This variety was founded on *Hartweg* no. 1706 collected in California, and this specimen must therefore be regarded as the type of *C. occidentalis*. Being in the Herbarium of the Royal Botanic Gardens, Kew, England, it cannot now be obtained, but an isotype is available at the Herbarium of the New York Botanical Garden, and it is unquestionably the California species.

However, in *Plantae Lindheimerianae*, no. 377, which is the plant to which Gray referred, is not the Californian species but the Texas one which in this paper I am calling *C. canadensis* var. *texensis*. This Texan plant was distinguished from the Californian one by Dr. Gray although no definite name was assigned to it. He did cite *C. reniformis* in synonymy, but this was merely a manuscript name. It seems reasonable that Lindheimer's no. 377 should become the type for my *C. canadensis* var. *texensis* instead of the type for *C. occidentalis*, as at first seems apparent. However, under the International Rules, the Hartweg plant becomes the type of the latter and no other designation is necessary or allowable.

That *C. occidentalis* is quite a distinct species from *C. canadensis* seems readily apparent to one who is familiar with the two. The western plant has pods which average much longer and broader than any other redbud and the flowers are slightly larger and more reddish in color. The shape of the leaves of this plant resembles very closely that of *C. canadensis* var. *texensis* but the average size of each leaf is smaller.

As I see it, this plant of California and neighboring states is a species with no contemporary connection, either phytogeographically or ecologically, with the eastern redbud. Further discussion on this point will be given under the heading of Phylogenetic Relationships.

Its distribution is most adequately discussed in Jepson's *Flora of California* and need hardly be repeated here. Arizona seems

its most eastern limit and no herbarium which I have examined has a record of its occurrence in New Mexico.

Although Rose was impressed by specimens from the Grand Canyon of the Colorado River in Arizona which seemed to differ from the typical Californian shrub, he never published his "*C. arizonica*" as a new species. He did, however, annotate several sheets with this nomen. We can assume that the annotations were made during the early part of his studies on the genus and that a more thorough examination of the material brought him to the conclusion that a distinct species or variety was not warranted.<sup>1</sup> With such a postulation I am in sympathy. I can see no obvious differences between the Arizona and the Californian material. Ecological conditions are sufficient to cause various modifications in the vegetative portions of the plants and it is these factors which must be taken into consideration in studying speciation in one genus over a widespread area.

The nomen "*arizonica*" unfortunately got into print in two different bulletins published by the United States National Park Service: Plants of the Grand Canyon Nat. Park by Pauline Mead Patraw, Tech. Bull. 6. 23 (1932); and Trees of Grand Canyon Nat. Park by Natt N. Dodge, Nat. Hist. Bull. 3. 56 (1936). Since in each case "*C. arizonica*" is a mere *nomen*, without description, the name must be discarded as invalid.

E. L. Greene was perhaps as great a "splitter" as American systematic botany has yet encountered. In *Cercis* (as in most other genera) his new species are numerous and all appear to be unsound. Careful and critical analysis reveals them to be merely

<sup>1</sup> There is in the Herbarium of the New York Botanical Garden an herbarium sheet on which is pasted the correspondence between Dr. W. H. Camp of that institution and Mr. W. A. Dayton, Senior Forest Ecologist, Forest Service, U. S. D. A. These letters written in 1936 pertain to the possibility of the occurrence of *C. occidentalis* in Utah, and its relation, if any, to *C. orbiculata* Greene. Camp assures Dayton that Britton & Rose considered *C. orbiculata* to be merely a synonym for *C. occidentalis* and that there is only one station for it in Utah, Diamond Valley (*L. N. Goodding*, no. 899). He goes on to say: "*Cercis occidentalis*, on the basis of our material, seems to be somewhat more common in Arizona, with specimens from Pagumpa, Kayenta, the Grand Canyon and an Otto Kuntze specimen without definite locality. According to the annotation labels, these all were put into a provisional species—'*C. arizonica*' by Dr. Rose between 1922 and 1927. The 'species,' however, was never published, and after carefully examining the Arizona specimens and the one from Utah in conjunction with the California material, including the type material seen by Torrey (which rests in our herbarium), I am of the opinion that Britton & Rose were quite justified in keeping all the material from these three states in *Cercis occidentalis* Torrey."

ecological variants in the broadest sense of the term, and by no systematist today are these species of *Cercis* considered valid. In this genus the types from which Greene described *C. latissima*, and *C. orbiculata* are not at all different from *C. occidentalis* in fundamental characters although superficially and to an untrained eye they do differ.

This species even today is frequently confused with the Texas redbuds and several manuals on California botany list its range as "east to Texas." For many years it was considered to be identical with Mexican and Texan material but Britton and Rose pointed out that *C. occidentalis* did not occur in those regions.

2. *C. CANADENSIS* L., Var. **typica**. Small to large tree 7–12 m. high; trunk straight, separating into stout branches about 3 m. from the ground and forming a wide, flat head; bark dark gray to grayish brown, punctate with numerous dark gray lenticels; stems and branchlets glabrous throughout: leaves broadly ovate to ovate-cordate, dull green on both surfaces and never shining, glabrous above, more or less pubescent below or with merely tufts of hairs along the veins and midrib, palmately 7–9-veined (more frequently 7), entire, membranaceous when young, at maturity becoming thicker and somewhat subcoriaceous but never truly coriaceous, 6–15 cm. broad, 5–10 cm. long (from apex to top of sinus); base cordate to subtruncate with a broad (max. 6 cm.) or shallow (min. 1 cm.) sinus; apex acute to subacuminate or more often abruptly contracted into a short point; petioles of mature leaves glabrous, 3–5 cm. long; stipules caducous: flowers in sessile clusters appearing in the spring before the leaves, 2–6 flowers in each cluster, magenta to purplish pink; corolla obscurely papilionaceous, 6–10 mm. long; flowering pedicels 6–10 mm. long: pods numerous but not so abundant as in *C. occidentalis*, oblong, flat, the upper suture with a winged margin, 6–10 cm. long, 0.8–1.8 cm. broad at maturity, long-attenuate at apex; fruiting pedicels divaricate, reflexed or arcuate, 9–14 mm. long; seeds oblong to suborbicular, 4–5 mm. long.—*C. canadensis* L., Sp. Pl. **1**. 374 (1753); Lamarck, Dict. **2**. 586 (1783); Michaux, Fl. Bor.-Am. **1**. 265 (1803); Persoon, Synop. **1**. 454 (1807); Pursh, Fl. Am. Sept. **1**. 308 (1814); Nuttall, Gen. **1**. 283 (1818); DC., Prod. **2**. 518 (1825); Hooker, Fl. Bor.-Am. **1**. 167 (1829); T. & G., Fl. N. Am. **1**. 392 (1838); Dietrich, Synop. **2**. 1515 (1843); Chapman, Fl. s. U. S. 114 (1860); Sargent, For. Trees N. Am., 10th Census U. S. **9**. 61 (1884); Sargent, Silva N. Am. **3**. 95. tab. 133 (1892); Mohr, Pl. Life Ala. in Contr. U. S. Nat'l Herb. **6**. 555 (1901); Britton, Man. Fl. n. U. S. & Can. 529



(1901); Small, Fl. se. U. S. 584 (1903); Robinson & Fernald in Gray, Man. ed. 7. 505 (1908); Britton & Brown, Ill. Fl. ed. 2. 2. 335 (1913); Small, Fl. se. U. S. ed. 2. 584 (1913); Sargent, Man. Trees N. Am. ed. 2. 604 (1922); Britton & Rose in N. Am. Fl. 23, pt. 4. 202 (1930); Rydberg, Fl. Pr. & Pl. 451 (1932); Small, Man. se. Fl. 659 (1933); Stemen & Myers, Okla. Fl. 214 (1937); Steyermark, Spring Flowers of Missouri. 291 (1940); Deam, Fl. Indiana. 585 (1940). *C. canadensis*  $\beta$ . *pubescens* Pursh, Fl. Am. Sept. 1. 308 (1814). *C. dilatata* Greene in Fedde, Rep. Sp. Nov. 11. 110 (1912). *C. ellipsoidea* Greene in Fedde, Rep. Sp. Nov. 11. 110 (1912).—Deep rich woods or in flood-plains and river thickets from Conn. w. to Iowa, south through Kans. & Okla. to Tex. and ne. Mex. The following are a few characteristic specimens. CONNECTICUT: dry woods, West Rock, New Haven, "apparently native," *E. H. Eames*, no. 11,521 [G]. PENNSYLVANIA: woods along stream tributary to Schuylkill River, w. of Shawmont, Philadelphia Co., *Fogg*, no. 11,741 [G]; streamlet tributary to Perkiomen Cr., near Arcola, Montgomery Co., *Long & St. John*, no. 2420 [G]; damp woods, Bear Creek, Allegheny Co., *J. A. Schafer*, no. 645 [G]. DELAWARE: rich woods near Centreville, *A. Commons*, 2 July 1866 [G]; Rockland, *Edw. Tatnall*, without date or number [G]. MARYLAND: moist, sandy, loamy woods along Great Bohemia Creek, Middle Neck, Cecil Co., *Long*, no. 37,303 [G]; edge of woods near Plummer Island, *Blake*, no. 9342 [G, US]. DISTRICT OF COLUMBIA: woody hillsides, vicinity of Washington, *E. S. Steele*, 20 Ap. & 15 May 1896 [G]. WEST VIRGINIA: Parkersburg, Wood Co., *W. V. U. Botanical Expedition*, 19 June 1929 [G, US]; woods near White Sulphur Springs, Greenbrier Co., *F. W. Hunnewell*, no. 2668 [G]. VIRGINIA: western slope of Bull Run Mts., Fauquier Co., *Allard*, no. 276 [G, US]; rocky wooded slope, south bank of Roanoke River, Goode's Bridge, Mecklenburg Co., *Fernald & Long*, no. 7083 [G]; Bedford Co., *A. H. Curtiss*, 10 Ap. & 1 Oct. 1871 [G]; rich wooded slope, 4 miles s. of Stony Creek, *Fernald & Long*, no. 8311 [G]. NORTH CAROLINA: Biltmore, *Biltmore Herb.*, no. 314b [G, US]; creek bank near Raleigh, Wake Co., *Godfrey*, 31 Mar. 1938 [G]. SOUTH CAROLINA: rich woodland, junction of Santee Canal and Santee River west of Pineville, Berkeley Co., *Godfrey & Tryon*, no. 1587 [G]; *S. Carolina*, ex. herb. *J. Torrey*, without date or number [G]. GEORGIA: circa urbem Augusta, *Olney & Metcalf*, no. 24 [G]. FLORIDA: Fernandina, *C. E. Faxon*, Feb. 1873 [G]; Florida, *Chapman*, without date or number [G]. MICHIGAN: up Huron River, ne. of waterworks, Ann Arbor, Washtenaw Co., *Burnham*, 6 May, 14 June 1899 [G]; primitive forest, South Haven, *L. H. Bailey*, 22 June 1880 [G]. ILLINOIS: rich woods, clay soil, Decatur, *Gleason*, no. 209 [G]; along streams, Peoria, common, *F. E. McDonald*, Ap.–July 1904 [G]; rocky

grassy slope at edge of island, Altorf Island, Kankakee Co., *Lansing & Sherff*, no. 7 [G]. KENTUCKY: along Cumberland River, Bell County, *T. H. Kearney*, no. 439 [G]; east of Tygarts River near Cascade Caverns in rich woods, Carter Co., *L. B. Smith, Hodgdon, et al*, no. 3493 [G]. TENNESSEE: edge of woods, Kingston Springs, Cheatham Co., *Svenson*, no. 48 [G]; on limestone ledge west of Whitwell, Marion Co., *E. B. Harger*, no. 7794 [G]. ALABAMA: woods, Troy, *G. H. Leland*, 23 Feb. 1891 [G]. MISSISSIPPI: near campus in woods, U. of Miss., *J. Wise*, 3 Mar. 1923 [OU]. IOWA: Hamburg, *Pammel*, 4 July 1914 [G]; wooded bluffs, Decatur Co., *Fitzpatrick & Fitzpatrick*, 7 May 1898 [G]. MISSOURI: woods, Whiteside, *John Davis*, no. 958 [G]; sparsely wooded hillsides se. Cedar Gap, Ozark Mts., *O. E. Lansing, Jr.*, no. 3075 [G]. ARKANSAS: creek banks and bottoms, Jasper, Newton Co., *Demaree*, no. 6378 [G]. LOUISIANA: Louisiana, *Dr. Carpenter, ex. herb. George Thurber*, without date or number [G]. KANSAS: low woods, Riley Co., *J. B. Norton*, nos. 121 and 121a [G]; near city limits of Hays, Ellis Co., *Earl Bondy*, no. 528 [OU]. OKLAHOMA: river bottoms, near Idabel, McCurtain Co., *H. W. Houghton*, no. 3755 [G]; flood plain of S. Canadian River, 3 miles e. of Norman, Cleveland Co., *Hopkins & Van Valkenburgh*, no. 1205 [OU]; rich woods in Hunton Lime & Woodford Chert Formation near Mill Creek, Johnson Co., *Hopkins*, no. 4865 [OU]. TEXAS: woods, Corsicana, Navarro Co., *Reverchon*, 25 April 1902 [MBG]; near Houston, *Lindheimer*, 1843 [G]; Houston, *G. L. Fisher*, 10 Mar., 11 Apr. 1913 (as *C. reniformis*) [NY]; near Weatherford, *S. M. Tracy*, no. 8030 (as *C. occidentalis*) [G, US, NY]. MEXICO: small tree on Hacienda Vista Hermosa, 35 miles s. of Monterrey, Nuevo Leon, *S. S. White*, no. 1538 [G]; above El Rosario, vicinity of Marmolejo, Sierra de San Carlos, Tamaulipas, *H. H. Bartlett*, no. 10855 [US]. *Fl.* Mar.—Apr. MAP IV.

Our familiar redbud, which is the state tree of Oklahoma, has the mature leaves, when dry, thin in texture and very brittle on the herbarium sheets. They are invariably cordate in general outline and usually acute at the apex.

Greene's *C. ellipsoidea* appears to be merely *C. canadensis* in every detail. I have before me his type (from the United States National Herbarium), collected by J. A. Gaut in the Wichita Mountains of Oklahoma (no. 167) and it differs in no way from my conception of, nor from the available descriptions of, *C. canadensis*.

In habitat it is found more frequently in moist woods and floodplains or river thickets and even in the dry Arbuckle

Mountains one finds it most frequently in low woods in the soils of the Woodford chert formation. When it grows on soils derived from other geological formations, it will always occur on the border of one of the small streams running through the region. One concludes, therefore, that it cannot tolerate conditions which are extremely xeric.

Geographically, it extends from New Jersey south to northern Florida, west to southern Ontario, and southward through the middle prairie states to Texas and northeastern Mexico. I emphasize this broad distribution here, for I consider this species to be the one from which the other entities were derived. This point will be discussed later under Phylogenetic Relationships.

2a. *C. CANADENSIS* f. *GLABRIFOLIA* Fern. Differing from the typical form only in having the leaves quite glabrous on both surfaces.—*RHODORA*, **38**. 234 (1936); Steyermark, Spring Flowers Missouri. 291 (1940); Deam, Fl. Indiana. 586 (1940). *C. georgiana* Greene in Fedde, Rep. Sp. Nov. **11**. 110 (1912).—Throughout the range of the typical form.

This form seems fairly common. About one-half the specimens which I have examined have the leaves quite glabrous on both surfaces and even on the principal veins of the lower surface there is a conspicuous absence of any form of pubescence.

Greene's type of *C. georgiana* (*R. M. Harper*, no. 363, Pigeon Mt., Walker Co., Georgia, 3 Aug. 1900) illustrates such a plant but his epithet cannot be used for this form under Article 16 of the International Rules. Fernald's much more suitable name for this glabrous entity is quite valid and must stand.

Because it would add considerably to the length of this paper to cite specimens of this form, and because such citations are hardly necessary in an entity whose only difference from the typical form is the absence of pubescence, such citations have purposely been omitted.

2b. *C. CANADENSIS*, var. **texensis** (S. Wats.), n. comb. Tall shrub producing a clump of erect, clustered stems, more rarely tree-like, at maturity 4–10 m. high; bark light red-brown becoming gray-brown in age; stems and branchlets glabrous throughout at all times: leaves reniform to orbicular or more rarely reniform-cordate to orbicular-cordate, deep rich green becoming dark green in late summer, glabrous and very glaucous on both surfaces giving a shining, waxy appearance even when dried, palmately 7–9-veined, entire or undulate and somewhat

repand, very coriaceous, 6–15 cm. broad, 4–11 cm. long (from apex to top of sinus); base cordate with a broad (max. 3 cm.) to narrow and nearly closed (min. 4 mm.) sinus; apex acute or retuse to emarginate, rarely cuspidate and more rarely rounded; petioles of mature leaves glabrous, 2–5 cm. long, stipules caducous: flowers in sessile clusters or fascicles appearing in very early spring before the leaves, 2–6 flowers in each cluster, corolla magenta-pink, 6–10 mm. long; flowering pedicels 6–10 cm. long, 0.8–1.8 cm. broad at maturity, attenuate at apex; fruiting pedicels divaricate, reflexed or arcuate, 9–14 mm. long; seeds oblong to suborbicular, 4–5 mm. long.—*C. occidentalis* var. *texensis* S. Wats., *Bibl. Index*. 209 (1878). *C. occidentalis*, var., A. Gray in *Bost. Journ. Nat. Hist.* **6**: 177 (1850). *C. reniformis* Engelm. ex S. Wats. in *Proc. Am. Acad.* **17**. 348 (1882); Coulter, *Man. Phan. & Pterid. w. Tex.* in *Contrib. U. S. Nat'l. Herb.* **2**. 91 (1891); Brit. & Rose in *N. Am. Fl.* **33**, pt. 4. 202 (1930); Sarg., *Man. Trees N. Am.* ed. 3. 604 (1933).<sup>1</sup> *C. texensis* Sarg. in *Garden & Forest* **4**. 488 (1891); and *Silva of N. Am.* **3**. 97 (1893). *C. nitida* Greene in *Fedde, Rep. Sp. Nov.* **11**. 110 (1912). *C. occidentalis* Torr. in Coulter, *Man. Phan. & Pterid. w. Tex.* 91 (1891) and in *Small, Fl. se. U. S.* eds. 1 & 2. 584 (1903; 1913), all as to plant described but not as to name.—Dry calcareous outcrops and escarpments, Arbuckle Mts. of se. Okla., e. & w. Tex., except the Panhandle, s. to ne. Mex. The following specimens are characteristic. OKLAHOMA: steep slopes and gully-bottoms of xeric pasture, Viola limestone, Arbuckle Mts., *Hopkins*, no. 4768 [OU]; limestone hills, near Turner Falls State Park, Arbuckle Mts., *E. J. Palmer*, no. 42,002 (as *C. reniformis*) (US, NY, MBG); Platt National Park, Antelope Spring, *G. M. Merrill*, no. 1186 (NY); limestone bluffs, Marietta, Love Co., *E. J. Palmer*, no. 10,411 (MBG). TEXAS: Flora Texana exsiccata, *Lindheimer*, nos. 377 & 377b (TYPE in MBG; ISOTYPES in G, US); thickets in rocky soil on the upper Guadalupe, *Lindheimer*, no. 366 (as *C. reniformis*, n. sp. Engelm.); in deep limestone canyon near Viaduct, Valverde Co., *E. J. Palmer*, no. 33,480 (as *C. occidentalis*) (NY, US, MBG); Kerrville, Kerr Co., *A. A. Heller*, no. 1653 (as *C. occidentalis*) (NY, US, MBG); rocky hill, Austin, *Elihu Hall*, no. 165 (as *C. occidentalis*) (NY, MBG); Comanche Springs near New Braunfels etc., *Lindheimer*, nos. 752 & 753 (as *C. occidentalis*) (NY, OU, G, US, MBG); small tree in canyon-bottom, 20 miles s. of Sweetwater, Nolan

<sup>1</sup> Although the copyright of 1933 was obtained after Sargent's death, the Library of Congress gave the printing which followed a separate card, indicating the fact that a third edition had been published. The first one appeared in 1905, the second in 1922 and the third in 1933. But no copyright was obtained for the reprinting of the second edition in 1926. Therefore, according to the Library of Congress, this 1933 edition is the third and not the fourth, although actually four printings have been made.

Co., *G. J. Goodman*, no. 2253 (as *C. occidentalis*) (NY, OU, G, MBG); high limestone hills, Johnsville, Erath Co., *E. J. Palmer*, no. 14,205 (MBG); woods along small stream near Brownwood, Brown Co., *E. J. Palmer*, no. 26,815 (MBG); stony upland, west Dallas, *Eggert*, 23 June 1899 (MBG); Coombs Branch, Dallas Co., *Reverchon*, 10 Sept. without year (MBG); dry rocky bluffs, Station Creek, Hood Co., *Reverchon*, 5 Sept. 1903 (MBG). MEXICO: Rancho Agua Dulce, moist wooded canyon on eastern slope of the Sierra de San Manuel near Muzquiz, Coahuila, *Wynd & Mueller*, no. 388 (NY). MAP II.

Sargent would have been correct in taking up the name *texensis* for this calciphilous plant of Oklahoma, Texas, and northeastern Mexico had he treated it as a variety. The name *C. reniformis* was merely cited as a manuscript one by Gray as constituting a separate variety to which he actually assigned no name whatsoever. Watson later supplied the variety with the name *texensis* and referred back for its validation to Gray's description ("floribus etiam paulo minoribus, foliis supra nitidioribus"—Bost. Journ. Nat. Hist. 6. 177). *Texensis*, rather than *reniformis* therefore becomes the first validly published name as a variety and must be used if the plant is regarded as such. Whereas, *C. reniformis*, taken up by Watson in 1882, would be the correct name if it were regarded as a separate species. This is in accordance with Article 16 of the International Rules.

In the field this variety looks very similar to typical *C. canadensis* but differs chiefly in having the leaves thick and leathery and very glaucous. Usually the shrub can be distinguished immediately by these glistening, shining leaves. In the typical form there is no sheen to the leaves; they are merely dull green.

In the Arbuckles the two often grow in close proximity, and I know of several localities where they grow side by side. So obvious is the difference in the mature leaves that even the dullest student in my classes in systematic botany can always distinguish one from the other, when he sees them in the field.

Studies have been made from early spring continuing through late fall in an attempt to find other characters by which to distinguish this variety from the typical one. But all have failed. The flowers are similar in every way, the pods are identical and so are the seeds.

Even the leaves, in many instances, are alike. In general, var. *texensis* possesses a leaf which is reniform in shape and often

the margins will be undulate to subrepand and the apices obtuse or rounded; but the leaves may sometimes be merely broadly cordate with an acute apex. I have seen different types of leaves on the same tree. And in *C. canadensis*, although the leaves are normally cordate and acute, the mature leaves in late fall will often be broadly ovate-reniform to subcordate. The sinus at the base of the leaf might be expected to be constant, in which case reniform and cordate leaves would be easily distinguished. But with the members of this genus such constancy appears absent, and cordate leaves may have either a broad sinus (as much as 6 cm.) or a very shallow one (1 cm.). That these discrepancies may occur on the same specimen is proved by field data.

In other words, my observations seem to indicate that the shape of the leaves is, at least in *Cercis*, one of the poorest possible characters to use. Leaf-texture is about the only real difference which I see between *C. canadensis* and *C. texensis* and because of this fact, I feel that *C. texensis* must be reduced in rank from a separate species to a variety of *C. canadensis*.

This variety occurs almost exclusively on the old paleozoic limestones of northern Mexico, Texas, and the Arbuckle Mountains of Oklahoma where it is very common. No records for its occurrence in New Mexico are available and in Oklahoma it seems quite absent from the other and more youthful limestone areas in the state. In the Arbuckles one can always spot it on the driest and most exposed outcrops of pure limestone, chiefly in the Viola, Hunton, and Arbuckle formations. But, in numerous instances it grows near Honey Creek, where that small stream flows through the Viola hills, within a few feet of *C. canadensis*, which requires considerable moisture.

In general, a redbud found in the Arbuckles (at least when found in the flowering stage) is said to be *C. canadensis* if it grows on the banks of Honey Creek or in the woodland soils of the Woodford chert or Colbert Porphyry. But if it occurs on the higher, exposed, and quite dry outcrops of lime, it is said to be the var. *texensis*. Actually, *in the flowering condition one cannot tell the two plants apart* unless one knows from what location the specimen came, and even then the determination may not be foolproof. The young leaves of both are shining and only acquire

(in the case of *C. canadensis*) the dull green aspect during later months. Herbarium and field data agree perfectly in supporting this conclusion.

The above facts are mentioned with considerable embarrassment, but perhaps they will aid in making more plausible my reasons for reducing *C. texensis* in rank. When in their early stages of development two plants are so alike even in the field that they cannot be readily distinguished, it is high time that someone investigated the case more thoroughly.

Because the California plant was so long considered to be identical with this Texas-Mexican one, its distribution has been incorrectly given in many of the manuals and floras. In both editions of Small's Flora the *C. occidentalis* is this plant while in Coulter's Manual of the Phanerogams of Western Texas the *C. occidentalis* and the *C. reniformis* are both the same plant and are both merely synonyms for this variety. Likewise, in all the manuals of California botany the range of *C. occidentalis*, which is given as extending to western Texas, is inaccurate due to the fact that no differentiation was made between the two different entities.

In Sargent's Silva of North America (vol. 3) the last paragraph on page 97 reads as follows: "*Cercis texensis* was discovered by Jean Louis Berlandier at Comancheries, in the valley of the lower Rio Grande, in November, 1828." Then, in a footnote on the same page he adds: "*Cercis texensis* was named by Engelmann in MSS. *Cercis reniformis*, but was not published." This gives the impression that the type for this plant should be the Berlandier specimen, but such appears to be not the case. That herbarium sheet in the collection of the Missouri Botanical Garden bears no nomenclatorial annotation whatsoever on the original label. On the sheet itself (but not on the label) is a notation as follows: "According to Prof. Sargent this is part of probably the first collection of this species." But on the other hand, a Lindheimer specimen (no. 366) bears the annotation *on the label itself* "*reniformis* n. sp." which I take to be the material which Engelmann studied when he named the species. However, because this specimen had to be dug out of an herbarium, whereas Lindheimer's no. 377 is cited in a published work, it seemed best to designate the latter as the type for this variety.

2c. *C. CANADENSIS* var. **mexicana** (Rose), n. comb. Similar to var. *texensis* except for the woolly tomentum on the young branchlets and petioles and for the under surface of the leaves, which is pubescent especially on the veins and midrib.—*C. mexicana* Rose in N. Am. Fl. **23**, pt. 4. 202 (1930).—Dry rocky calcareous hills, e. & c. Tex. & N. Mex., south to Mexico. The following are characteristic specimens. TEXAS: rocky bluffs, Brown Co., *Reverchon*, Apr. 1882 (as *C. reniformis*) (MBG, US); rocky hills, Coombs Branch, Dallas Co., *Reverchon*, no. 2998 (as *C. reniformis*) (MBG); Sanderson, Marathon Rd., 44 mi. from Marathon, Terrell Co., *Ferris & Duncan*, no. 2828 (MBG); calcareous hills near Blackwell, Nolan Co., *E. J. Palmer*, no. 34616 (as *C. reniformis*) (MBG); Sheffield, *M. E. Jones*, no. 25931 (as *C. occidentalis*) (MBG); Brewster Co., *V. L. Cory*, no. 1725 (TAM, G); common in woods near Dallas, *B. F. Bush*, no. 659 (as *C. reniformis*) (MBG, NY); Wade Canyon, Chisos Mts., Brewster Co., *O. E. Sperry*, no. 593 (as *C. reniformis*) (US); Sanderson, *C. R. Orcutt*, no. 722 (US); near Austin, *F. V. Coville*, no. 1815 (as a new species, Greene, ined.) (US). NEW MEXICO: without locality and without date, only the notation: "Camels eat this," *Mr. Blake* [NY]. MEXICO: 21 miles se. of Monclova, Caracol Mts., Coahuila, *Dr. Edward Palmer*, Sept. 1880 (as *C. reniformis*) [G]; Saltillo, *Dr. J. Gregg*, no. 107 [G]; Sierra Madre above Monterrey, Nuevo Leon, *Pringle*, no. 10215 (as *C. occidentalis*) [G, NY, US]; Bagre, Minas de San Rafael, San Luis Potosi, *Purpus*, no. 5187 [TYPE in US, ISOTYPES in NY, G]; El Barrendo near Muzquiz, Coahuila, *S. S. White*, no. 1853 [G]; mountain stream, se. of Saltillo, Coahuila, *O. M. Clark*, no. 6690 [OU]. *Fl.* Mar.—Apr. MAP III.

This plant differs from the typical form and from the var. *texensis* only in having the young branches and petioles covered with a brownish, very tomentose pubescence.

The leaves vary considerably. Those of the type and isotypes (*Purpus*, no. 5187) have them distinctly ovate with a cordate base and acute apex and a shallow sinus, but very coriaceous in texture. In this respect they resemble the leaves of the typical form, but because of their texture and sheen they also resemble the var. *texensis*. In many of these specimens the leaves not only have the sheen and the texture of the var. *texensis* but also have the general reniform shape. The very great difference in leaf-shape of this variety makes evident once again the fact that this character is most unstable. It appears that the more common leaf-shape of the var. *mexicana* is the reniform one and because of this, one regrets that Rose did not assign a specimen illus-



trating this shape as his type, instead of a plant having rather cordate leaves, as the *Purpus* one. In fact, when I laid out on a table all the herbarium sheets of this variety (*mexicana*) one of my students came along accidentally and was so impressed by the difference in leaf shapes that when I asked him whether he thought all the plants belonged to the same species he could not help from exclaiming: "Why, man, even a blind man could see that you've got several species there!" In vain did both of us endeavor to seek differences other than mere leaf-shape, but to no avail. His final conclusions, after working with me for a couple of days, substantiate mine, that the plant differs from the others only by the presence of the very characteristic pubescence.

Nor do the flowers, fruits, or seeds of var. *mexicana* differ either from the typical form of this species or from the var. *texensis*. This same student even suggested that the palmate veins at the base of the leaves be counted. Being grateful for any suggestions which might help me to differentiate these three entities on some basis other than those already described, this was done. There appears to be no constancy in this feature, the veins varying from 7 to 9 in the typical form and in each of the different varieties. Therefore, the conclusion that the var. *mexicana* represents merely another variety of the typical form was further substantiated.

The plant is quite common on the limestone hills and bluffs of the Edwards Plateau area of Texas where it appears almost dominant (with *C. canadensis* var. *texensis* often becoming a co-dominant with it). It also is frequent in the Trans-Pecos area of that state. From New Mexico there is available only one specimen, without definite locality and with a label which bears the annotation: "Plants of Texas and New Mexico." This label has the words "Texas and" scratched out, which obviously places the plant in the latter state. But the only comment on the label appears the cryptic one: "Camels eat this." Dr. W. H. Camp of the New York Botanical Garden has written to Mr. W. A. Dayton (see comments above regarding *C. arizonica*) concerning this specimen in his usual humorous vein, as follows: "I don't suppose that overgrazing by this animal is a serious problem, at least not in New Mexico." Further collections from that state should be obtained before it would be safe to list it definitely

from that region. Its occurrence is not listed in Wooton & Standley's *Flora of New Mexico*, which volume carries no mention of the genus *Cercis* whatsoever.

From old Mexico I have seen specimens, also growing in calcareous habitats, in the northern and central regions.

One station near West Dallas, Texas, is represented by several specimens from the Reverchon Herbarium which is now incorporated in the Herbarium of the Missouri Botanical Garden. Because the plant is found in Dallas, which is only about one hundred miles south of the Oklahoma line, we have been hoping to be able to include it in the flora of the Arbuckle Mountains. Diligent field work in that area has not, at the present writing, revealed its occurrence there.

PHYLOGENETIC RELATIONSHIPS. My postulation regarding the phylogeny of *Cercis* may be summed up briefly. It appears to me as though *C. canadensis*, the Appalachian plant which now covers so much of eastern North America, must be regarded as the oldest entity on this continent.

*C. occidentalis* probably evolved originally as a variety of *C. canadensis* with its range extending westward. Then, being cut off from its relatives by climatic and physiographic factors, it was unable to back-cross with its parent and hence developed as a separate entity. That geographic isolation is a cogent force in the development of new species is well known, and, in my concept, *C. occidentalis* beautifully illustrates this fact.

Var. *texensis* also evolved from *C. canadensis*, probably on the old limestones of the Comanchian seabed in central North America,<sup>1</sup> and its coriaceous leaf might have had a positive survival value in the very calcareous soil. But it was never entirely remote from, nor cut off from, the typical form and hence its present distribution somewhat overlaps that of *C. canadensis* although it has migrated considerably southwestward on the limestone soils. Geographically, it illustrates our current interpretation of a taxonomic variety and morphologically it further substantiates this concept.

Later, and possibly due to climatic conditions which may have brought about a mutation or a chromosomal aberration, a third entity arose. This grew on the old limestones also but in a more

<sup>1</sup> For extent of this seabed see Hopkins, in RHODORA. 40. 428 (1938).

xeric environment. In this case the adaptive response for this extreme might be observed in the tomentose pubescence of twigs and petioles, but otherwise there were no obvious differences.

These two varieties then increased the geographic distribution of the genus as a whole so that its present range includes most of central, east central, and south central North America. *C. canadensis* var. *typica* and the varieties *texensis* and *mexicana* are not too unlike to make such an explanation for their ranges plausible. And *C. occidentalis*, because of its isolation, would of course have been expected to evolve into a separate species morphologically unlike its relatives.

Regarding the glabrous form of *C. canadensis* it appears to be merely an ecological response and occurring as it does throughout the range of the typical form is worthy only of recognition as a form rather than as a variety.

The geographic distribution of the genus in America is illustrated by the accompanying maps.

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## A NOTE ON SAGITTARIA KURZIANA

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When Glück<sup>1</sup> described his *Sagittaria Kurziana* he found no mature achenes on the plants collected. As a result his description lacks data concerning this fundamental structure. Small<sup>2</sup> also had no achenes of this species for study when he reduced it to synonymy. As a result the status of this form has been uncertain.

A number of plants of *S. Kurziana* were collected from the St. Marks river at Newport, west Florida, one of the stations where Glück collected type material. Achenes were obtained from one of the plants growing in a green-house pool as the result of crossing one of its pistillate flowers with pollen from a plant of *S. stagnorum* Small. As there were no staminate flowers of *S. Kurziana* in bloom at the time this was the only source of likely pollen and so was used. The resulting mature achenes contained

<sup>1</sup> Glück, Hugo. 1927. Bull. Torr. Bot. Club 54: 257-261.

<sup>2</sup> Small, J. K. 1933. Manual of the Southeastern Flora, p. 24.